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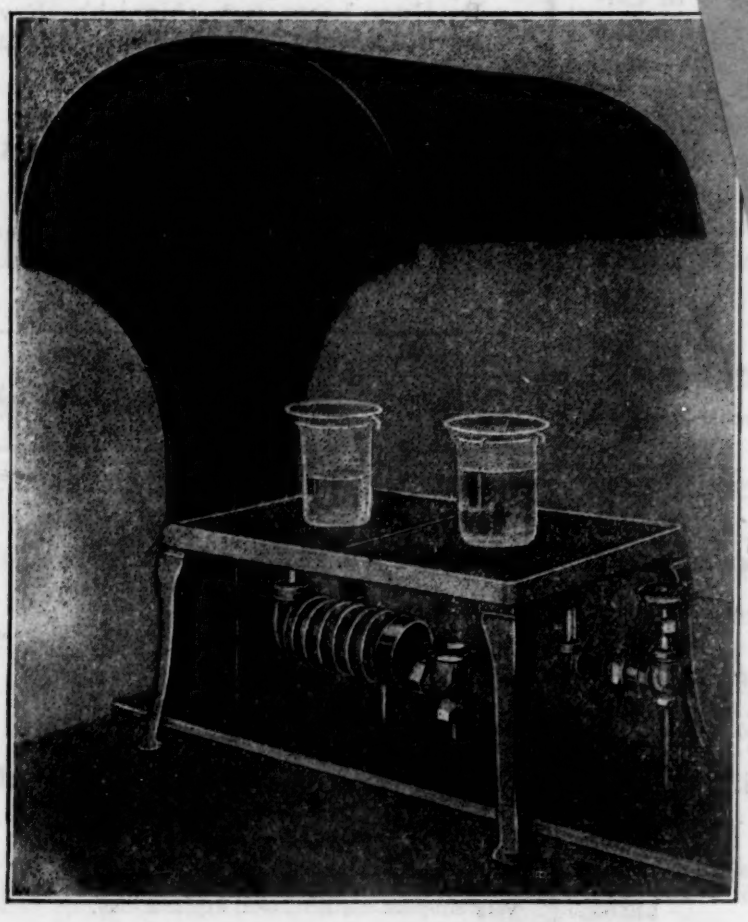

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ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

II

I TURN now to a question of scientific interest which is attracting general attention at the present time. It is directly connected with Lord Kelvin's address fifty years ago.

The molecular theory of matter—a theory which in its crudest form has descended to us from the earliest times and which has been elaborated by various speculative thinkers through the intervening ages, hardly rested upon an experimental basis until within the memory of men still living. When Lord Kelvin spoke in 1871, the best-established development of the molecular hypothesis was exhibited in the kinetic theory of gases as worked out by Joule, Clausius, and Clerk-Maxwell. As he then said, no such comprehensive molecular theory had ever been even imagined before the nineteenth century. But, with the eye of faith, he clearly perceived that, definite and complete in its area as it was, it was "but a well-drawn part of a great chart, in which all physical science will be represented with every property of matter shown in dynamical relation to the whole. The prospect we now have of an early completion of this chart is based on the assumption of atoms. But there can be no permanent satisfaction to the mind in explaining heat, light, elasticity, diffusion, electricity and magnetism, in gases, liquids and solids, and describing precisely the relations of these different states of matter to one another by statistics of great numbers of atoms when properties of the atom itself are simply assumed. When the theory, of which we have the first instalment in Clausius and Maxwell's work, is complete, we are but brought face to face with a superlatively grand ques-

[1] Edinburgh, September 7, 1921.

tion: "What is the inner mechanism of the atom?"

If the properties and affections of matter are dependent upon the inner mechanism of the atom, an atomic theory, to be valid, must comprehend and explain the all. There can not be one kind of atom for the physicist and another for the chemist. The nature of chemical affinity and of valency, the modes of their action, the difference in characteristics of the chemical elements, even their number, internal constitution, periodic position, and possible isotopic rearrangements must be accounted for and explained by it. Fifty years ago chemists, for the most part, rested in the comfortable belief of the existence of atoms in the restricted sense in which Dalton, as a legacy from Newton, had imagined them. Lord Kelvin, unlike the chemists, had never been in the habit of "evading questions as to the hardness or indivisibility of atoms by virtually assuming them to be infinitely small and infinitely numerous." Nor, on the other hand, did he realize, with Boscovich, the atom "as a mystic point endowed with inertia and the attribute of attracting or repelling other such centers." Science advances not so much by fundamental alterations in its beliefs as by additions to them. Dalton would equally have regarded the atom "as a piece of matter of measurable dimensions, with shape, motion, and laws of action, intelligible subjects of scientific investigation."

In spite of the fact that the atomic theory, as formulated by Dalton, has been generally accepted for nearly a century, it is only within the last few years that physicists have arrived at a conception of the structure of the atom sufficiently precise to be of service to chemists in connection with the relation between the properties of elements of different kinds, and in throwing light on the mechanism of chemical combination.

This further investigation of the "superlatively grand question—the inner mechanism of the atom,"—has profoundly modified the basic conceptions of chemistry. It has led to a great extension of our views concerning the real nature of the chemical elements. The discovery of the electron, the production of helium in the radioactive disintegration of atoms, the recognition of the existence of isotopes, the possibility that all elementary atoms are composed either of helium atoms or of atoms of hydrogen and helium, and that these atoms, in their turn, are built up of two constituents, one of which is the electron, a particle of negative electricity whose mass is only 1/1800 of that of an atom of hydrogen, and the other a particle of positive electricity whose mass is practically identical with that of the same atom—the outcome, in short, of the collective work of Soddy, Rutherford, J. J. Thomson, Collie, Moseley and others—are pregnant facts which have completely altered the fundamental aspects of the science. Chemical philosophy has, in fact, now definitely entered on a new phase.

Looking back over the past, some indications of the coming change might have been perceived wholly unconnected, of course, with the recent experimental work which has served to ratify it. In a short paper entitled "Speculative ideas respecting the constitution of matter," originally published in 1863, Graham conceived that the various kinds of matter, now recognized as different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement. This idea, in its essence, may be said to be as old as the time of Leucippus. To Graham as to Leucippus "the action of the atom as one substance taking various forms by combinations unlimited, was enough to account for all the phenomena of the world. By separation and union with constant motion all things could be done." But Graham developed the conception by independent thought, and in the light of experimentally ascertained knowledge which the world owes to his labors. He might have been cognizant of the speculations of the Greeks, but there is no evidence that he was knowingly influenced by them. In his paper Graham uses the terms atom and molecule if not exactly in the same sense that modern teaching de-

mands, yet very differently from that hitherto required by the limitations of contemporary chemical doctrine. He conceives of a lower order of atoms than the chemical atom of Dalton, and founds on his conception an explanation of chemical combination based upon a fixed combining measure, which he terms the *metron,* its relative weight being one for hydrogen, sixteen for oxygen, and so on with the other so-called "elements." Graham, in fact, like Davy before him, never committed himself to a belief in the indivisibility of the Daltonian atom. The original atom may, he thought, be far down.

The idea of a primordial ylé, or of the essential unity of matter, has persisted throughout the ages, and in spite of much experimental work, some of it of the highest order, which was thought to have demolished it, it has survived, revivified and supported by analogies and arguments drawn from every field of natural inquiry. This idea of course was at the basis of the hypothesis of Prout, but which, even as modified by Dumas, was held to be refuted by the monumental work of Stas. But, as pointed out by Marignac and Dumas, any one who will impartially look at the facts can hardly escape the feeling that there must be some reason for the frequent recurrence of atomic weights differing by so little from the numbers required by the law which the work of Stas was supposed to disprove. The more exact study within recent years of the methods of determining atomic weights, the great improvement in experimental appliances and technique, combined with a more rigorous standard of accuracy demanded by a general recognition of the far-reaching importance of an exact knowledge of these physical constants, has resulted in intensifying the belief that some natural law must be at the basis of the fact that so many of the most carefully determined atomic weights on the oxygen standard are whole numbers. Nevertheless there were well authenticated exceptions which seemed to invalidate its universality. The proved fact that a so-called element may be a mixture of isotopes—substances of the same chemical attributes but of varying atomic weight—has thrown new light on the question. It is now recognized that the fractional values independently established in the case of any one element by the most accurate experimental work of various investigators are, in effect, "statistical quantities" dependent upon a mixture of isotopes. This result, indeed, is a necessary corollary of modern conceptions of the inner mechanism of the atom. The theory that all elementary atoms are composed of helium atoms, or of helium and hydrogen atoms, may be regarded as an extension of Prout's hypothesis, with, however, this important distinction, that whereas Prout's hypothesis was at best a surmise, with little, and that little only weak, experimental evidence to support it, the new theory is directly deduced from well-established facts. The hydrogen isotope H_3, first detected by J. J. Thomson, of which the existence has been confirmed by Aston, would seem to be an integral part of atomic structure. Rutherford, by the disruption of oxygen and nitrogen has also isolated a substance of mass 3 which enters into the structure of atomic nuclei, but which he regards as an isotope of helium, which itself is built up of four hydrogen nuclei together with two cementing electrons. The atomic nuclei of elements of even atomic number would appear to be composed of helium nuclei only, or of helium nuclei with cementing electrons; whereas those of elements of odd atomic number are made up of helium and hydrogen nuclei together with cementing electrons. In the case of the lighter elements of the latter class the number of hydrogen nuclei associated with the helium nuclei is invariably three, except in that of nitrogen where it is two. The frequent occurrence of this group of three hydrogen nuclei indicates that it is structurally an isotope of hydrogen with an atomic weight of three and a nuclear charge of one. It is surmised that it is identical with the hypothetical "nebulium" from which our "elements" are held by astro-physicists to

be originally produced in the stars through hydrogen and helium.

These results are of extraordinary interest as bearing on the question of the essential unity of matter and the mode of genesis of the elements. Members of the British Association may recall the suggestive address on this subject of the late Sir William Crookes, delivered to the Chemical Section at the Birmingham meeting of 1886, in which he questioned whether there is absolute uniformity in the mass of the atoms of a chemical element, as postulated by Dalton. He thought, with Marignac and Schutzenberger, who had previously raised the same doubt, that it was not improbable that what we term an atomic weight merely represents a mean value around which the actual weights of the atoms vary within narrow limits, or, in other words, that the mean mass is "a statistical constant of great stability." No valid experimental evidence in support of this surmise was or could be offered at the time it was uttered. Maxwell pointed out that the phenomena of gaseous diffusion, as then ascertained, would seem to negative the supposition. If hydrogen, for example, were composed of atoms of varying mass it should be possible to separate the lighter from the heavier atoms by diffusion through a porous septum. "As no chemist," said Maxwell, "has yet obtained specimens of hydrogen differing in this way from other specimens, we conclude that all the molecules of hydrogen are of sensibly the same mass, and not merely that their mean mass is a statistical constant of great stability."[1] But against this it may be doubted whether any chemist had ever made experiments sufficiently precise to solve this point.

The work of Sir Norman Lockyer on the spectroscopic evidence for the dissociation of "elementary" matter at transcendental temperatures, and the possible synthetic intro-stellar production of elements, through the helium of which he originally detected the existence, will also find its due place in the history of this new philosophy.

[1] Clerk-Maxwell, Art. "Atom," *Ency. Brit.*, 9th Ed.

Sir J. J. Thomson was the first to afford direct evidence that the atoms of an element, if not exactly of the same mass, were at least approximately so, by his method of analysis of positive rays. By an extension of this method Mr. F. W. Aston has succeeded in showing that a number of elements are in reality mixtures of isotopes. It has been proved, for example, that neon, which has a mean atomic weight of about 20.2, consists of two isotopes having the atomic weights respectively of 20 and 22, mixed in the proportion of 90 per cent. of the former with 10 per cent. of the latter. By fractional diffusion through a porous septum an apparent difference of density of 0.7 per cent. between the lightest and heaviest fractions was obtained. The kind of experiment which Maxwell imagined proved the invariability of the hydrogen atom has sufficed to show the converse in the case of neon.

The element chlorine has had its atomic weight repeatedly determined, and, for special reasons, with the highest attainable accuracy. On the oxygen standard it is 35.46, and this value is accurate to the second decimal place. All attempts to prove that it is a whole number—35 or 36—have failed. When, however, the gas is analyzed by the same method as that used in the case of neon it is found to consist of at least two isotopes of relative mass 35 and 37. There is no evidence whatever of an individual substance having the atomic weight 35.46. Hence chlorine is to be regarded as a complex element consisting of two principal isotopes of atomic weights 35 and 37 present in such proportion as to afford the mean mass 35.46. The atomic weight of chlorine has been so frequently determined by various observers and by various methods with practically identical results that it seems difficult to believe that it consists of isotopes present in definite and invariable proportion. Mr. Aston meets this objection by pointing out that all the accurate determinations have been made with chlorine derived originally from the same source, the sea, which has been perfectly mixed for æons. If samples of the element could be obtained from some

other original source it is possible that other values of atomic weight would be obtained, exactly as in the case of lead in which the existence of isotopes in the metal found in various radioactive minerals was first conclusively established.

Argon, which has an atomic weight of 39.88, was found to consist mainly of an atomic weight of 40, associated to the extent of about 3 per cent. with an isotope of atomic weight 36. Krypton and xenon are far more complex. The former would appear to consist of six isotopes, 78, 80, 82, 83, 84, 86; the latter of five isotopes, 129, 131, 132, 134, 136.

Fluorine is a simple element of atomic weight 19. Bromine consists of equal quantities of two isotopes, 79 and 81. Iodine, on the contrary, would appear to be a simple element of atomic weight 127. The case of tellurium is of special interest in view of its periodic relation to iodine, but the results of its examination up to the present are indefinite.

Boron and silicon are complex elements, each consisting of two isotopes, 10 and 11, and 28 and 29, respectively.

Sulphur, phosphorus, and arsenic are apparently simple elements. Their accepted atomic weights are practically integers.

All this work is so recent that there has been little opportunity, as yet, of extending it to any considerable number of the metallic elements. These, as will be obvious from the nature of the methods employed, present special difficulties. It is, however, highly probable that mercury is a mixed element consisting of many isotopes. These have been partially separated by Brönsted and Hervesy by fractional distillation at very low pressures, and have been shown to vary very slightly in density. Lithium is found to consist of two isotopes, 6 and 7. Sodium is simple, potassium and rubidium are complex, each of the two latter elements consisting, apparently, of two isotopes. The accepted atomic weight of cæsium, 132.81, would indicate complexity, but the mass spectrum shows only one line at 133. Should this be confirmed cæsium would afford an excellent test case. The accepted value for the atomic weight is sufficiently far removed from a whole number to render further investigation desirable.

This imperfect summary of Mr. Aston's work is mainly based upon the account he recently gave to the Chemical Society. At the close of his lecture he pointed out the significance of the results in relation to the Periodic Law. It is clear that the order of the chemical or "mean" atomic weights in the periodic table has no practical significance; anomalous cases such as argon and potassium are simply due to the relative proportions of their heavier and lighter isotopes. This does not necessarily invalidate or even weaken the periodic law which still remains the expression of a great natural truth. That the expression as Mendeléeff left it is imperfect has long been recognized. The new light we have now gained has gone far to clear up much that was anomalous, especially Moseley's discovery that the real sequence is the atomic number, not the atomic weight. This is one more illustration of the fact that science advances by additions to its beliefs rather than by fundamental or revolutionary changes in them.

The bearing of the electronic theory of matter, too, on Prout's discarded hypothesis that the atoms of all elements were themselves built up of a primordial atom—his *protyle* which he regarded as probably identical with hydrogen—is too obvious to need pointing out. In a sense Prout's hypothesis may be said to be now reestablished, but with this essential modification—the primordial atoms he imagined are complex and are of two kinds—atoms of positive and negative electricity—respectively known as protons and electrons. These, in Mr. Aston's words, are the standard bricks that nature employs in her operations of element building.

The true value of any theory consists in its comprehensiveness and sufficiency. As applied to chemistry, this theory of "the inner mechanism of the atom" must explain all its phenomena. We owe to Sir J. J. Thomson its extension to the explanation of the periodic law, the atomic number of an element, and

of that varying power of chemical combination in an element we term valency. This explanation I give substantially in his own words. The number of electrons in an atom of the different elements has now been determined, and has been found to be equal to the atomic number of the element, that is to the position which the element occupies in the series when the elements are arranged in the order of their atomic weights. We know now the nature and quantity of the materials of which the atoms are made up. The properties of the atom will depend not only upon these factors but also upon the way in which the electrons are arranged in the atom. This arrangement will depend on the forces between the electrons themselves and also on those between the electrons and the positive charges or protons. One arrangement which naturally suggested itself is that the positive charges should be at the center with the negative electrons around it on the surface of a sphere. Mathematical investigation shows that this is a possible arrangement if the electrons on the sphere are not too crowded. The mutual repulsion of the electrons resents overcrowding, and Sir J. J. Thomson has shown that when there are more than a certain number of electrons on the sphere, the attraction of a positive charge, limited as in the case of the atom in magnitude to the sum of the charges on the electrons, is not able to keep the electrons in stable equilibrium on the sphere, the layer of electrons explodes and a new arrangement is formed. The number of electrons which can be accommodated on the outer layer will depend upon the law of force between the positive charge and the electrons. Sir J. J. Thomson has shown that this number will be eight with a law of force of a simple type.

To show the bearing of this result as affording an explanation of the Periodic Law, let us, to begin with, take the case of the atom of lithium, which is supposed to have one electron in the outer layer. As each element has one more free electron in its atom than its predecessor, glucinum, the element next in succession to lithium, will have two electrons in the outer layer of its atom, boron will have three, carbon four, nitrogen five, oxygen six, fluorine seven and neon eight. As there can not be more than eight electrons in the outer layer, the additional electron in the atom of the next element, sodium, can not find room in the same layer as the other electrons, but will go outside, and thus the atom of sodium, like that of lithium, will have one electron in its outer layer. The additional electron, in the atom of the next element, magnesium, will join this, and the atom of magnesium, like that of glucinum, will have two electrons in the outer layer. Again, aluminium, like boron, will have three; silicon, like carbon, four; phosphorus, like nitrogen, five; sulphur, like oxygen, six; chlorine, like fluorine, seven; and argon, like neon, eight. The sequence will then begin again. Thus the number of electrons, one, two, three, up to eight in the outer layer of the atom, will recur periodically as we proceed from one element to another in the order of their atomic weights, so that any property of an element which depends on the number of electrons in the outer layer of its atom will also recur periodically, which is precisely that remarkable property of the elements which is expressed by the periodic law of Mendeléeff, or the law of octaves of Newlands.

The valency of the elements, like their periodicity, is a consequence of the principle that equilibrium becomes unstable when there are more than eight electrons in the outer layer of the atom. For on this view the chemical combination between two atoms, A and B, consists in the electrons of A getting linked up with those of B. Consider an atom like that of neon, which has already eight electrons in its outer layer; it can not find room for any more, so that no atoms can be linked to it, and thus it can not form any compounds. Now take an atom of flourine, which has seven electrons in its outer layer; it can find room for one, but only one, electron, so that it can unite with one, but not with more than one, atom of an element like hydrogen, which has one electron in the

outer layer. Fluorine, accordingly, is monovalent. The oxygen atom has six electrons; it has, therefore, room for two more, and so can link up with two atoms of hydrogen: hence oxygen is divalent. Similarly nitrogen, which has five electrons and three vacant places, will be trivalent, and so on. On this view an element should have two valencies, the sum of the two being equal to eight. Thus, to take oxygen as an example, it has only two vacant places, and so can only find room for the electrons of two atoms; it has, however, six electrons available for filling up the vacant places in other atoms, and as there is only one vacancy to be filled in a fluorine atom the electrons in an oxygen atom could fill up the vacancies in six fluorine atoms, and thereby attach these atoms to it. A fluoride of oxygen of this composition remains to be discovered, but its analogue, SF_6, first made known by Moissan, is a compound of this type. The existence of two valencies for an element is in accordance with views put forward some time ago by Abegg and Bödlander. Professor Lewis and Mr. Irving Langmuir have developed, with great ingenuity and success, the consequences which follow from the hypothesis that an octet of electrons surrounds the atoms in chemical compounds.

The term "atomic weight" has thus acquired for the chemist an altogether new and much wider significance. It has long been recognized that it has a far deeper import than as a constant useful in chemical arithmetic. For the ordinary purposes of quantitative analysis, of technology, and of trade, these constants may be said to be now known with sufficient accuracy. But in view of their bearing on the great problem of the essential nature of matter and on the "superlatively grand question, What is the inner mechanism of the atom?" they become of supreme importance. Their determination and study must now be approached from entirely new standpoints and by the conjoint action of chemists and physicists. The existence of isotopes has enormously widened the horizon. At first sight it would appear that we should require to know as many atomic weights as there are isotopes, and the chemist may be appalled at such a prospect. All sorts of difficulties start up to affright him, such as the present impossibility of isolating isotopes in a state of individuality, their possible instability, and the inability of his quantitative methods to establish accurately the relatively small differences to be anticipated. All this would seem to make for complexity. On the other hand, it may eventually tend towards simplification. If, with the aid of the physicist we can unravel the nature and configuration of the atom of any particular element, determine the number and relative arrangement of the constituent protons and electrons, it may be possible to arrive at the atomic weight by simple calculation, on the assumption that the integer rule is mathematically valid. This, however, is almost certainly not the case, owing to the influence of "packing." The little differences, in fact, may make all the difference. The case is analogous to that of the so-called gaseous laws in which the departures from their mathematical expression have been the means of elucidating the physical constitution of the gases and of throwing light upon such variations in their behavior as have been observed to occur. There would appear, therefore, ample scope for the chemist in determining with the highest attainable accuracy the departures from the whole-number rule, since it is evident that much depends upon their exact extent.

These considerations have already engaged the attention of chemists. For some years past, a small international committee, originally appointed in 1903, has made and published an annual report in which they have noted such determinations of atomic weight as have been made during the year preceding each report, and they have from time to time made suggestions for the amendment of the tables of atomic weights, published in textbooks and chemical journals, and in use in chemical laboratories. In view of recent developments, the time has now arrived when the work of this international committee must

be reorganized and its aims and functions extended. The mode in which this should be done has been discussed at the meeting in Brussels, in June last, of the International Union of Chemistry Pure and Applied, and has resulted in strengthening the constitution of the committee and in a wide extension of its scope.

The crisis through which we have recently passed has had a profound effect upon the world. The spectacle of the most cultured and most highly developed peoples on this earth, armed with every offensive appliance which science and the inventive skill and ingenuity of men could suggest, in the throes of a death struggle must have made the angels weep. That dreadful harvest of death is past, but the aftermath remains. Some of it is evil, and the evil will persist for, it may be, generations. There is, however, an element of good in it, and the good, we trust, will develop and increase with increase of years. The whole complexion of the world—material, social, economic, political, moral, spiritual—has been changed, in certain aspects immediately for the worse, in others prospectively for the better. It behooves us, then, as a nation to pay heed to the lessons of the war.

The theme is far too complicated to be treated adequately within the limits of such an address as this. But there are some aspects of it germane to the objects of this association, and I venture, therefore, in the time that remains to me, to bring them to your notice.

The Great War differed from all previous internecine struggles in the extent to which organized science was invoked and systematically applied in its prosecution. In its later phases, indeed, success became largely a question as to which of the great contending parties could most rapidly and most effectively bring its resources to their aid. The chief protagonists had been in the forefront of scientific progress for centuries, and had an accumulated experience of the manifold applications of science in practically every department of human activity that could have any possible relation to the conduct of war. The military class in every country is probably the most conservative of all the professions and the slowest to depart from tradition. But when nations are at grips, and they realize that their very existence is threatened, every agency that may tend to cripple the adversary is apt to be resorted to—no matter how far it departs from the customs and conventions of war. This is more certain to be the case if the struggle is protracted. We have witnessed this fact in the course of the late war. Those who, realizing that in the present imperfect stage of civilization, wars are inevitable, yet strove to minimize their horrors, and who formulated the Hague Convention of 1899, were well aware how these horrors might be enormously intensified by the applications of scientific knowledge, and especially of chemistry. Nothing shocked the conscience of the civilized world more than Germany's cynical disregard of the undertaking into which she had entered with other nations in regard, for instance, to the use of lethal gas in warfare. The nation that treacherously violated the Treaty of Belgium, and even applauded the action, might be expected to have no scruples in repudiating her obligations under the Hague Convention. April 25, 1915, which saw the clouds of the asphyxiating chlorine slowly wafted from the German trenches towards the lines of the Allies, witnessed one of the most bestial episodes in the history of the Great War. The world stood aghast at such a spectacle of barbarism. German *Kultur* apparently had absolutely no ethical value. Poisoned weapons are employed by savages, and noxious gas had been used in Eastern warfare in early times, but its use was hitherto unknown among European nations. How it originated among the Germans—whether by the direct unprompted action of the Higher Command, or, as is more probable, at the instance of persons connected with the great manufacturing concerns in Rhineland, has, so far as I know, not transpired. It was not so used in the earlier stages of the war, even when it had become a war of position. It is notorious that the great chemical manufacturing establishments of

Germany had been, for years previously, sedulously linked up in the service of the war which Germany was deliberately planning—probably, in the first instance, mainly for the supply of munitions and medicaments. We may suppose that it was the tenacity of our troops, and the failure of repeated attempts to dislodge them by direct attack, that led to the employment of such foul methods. Be this as it may, these methods became part of the settled practise of our enemies, and during the three succeeding years, that is from April, 1915, to September, 1918, no fewer than eighteen different forms of poison—gases, liquids and solids—were employed by the Germans. On the principle of Vespasian's law, reprisals became inevitable, and for the greater part of three years we had the sorry spectacle of the leading nations of the world flinging the most deadly products at one another that chemical knowledge could suggest and technical skill contrive. Warfare, it would seem, has now definitely entered upon a new phase. The horrors which the Hague Convention saw were immanent, and from which they strove to protect humanity, are now, apparently, by the example and initiative of Germany, to become part of the established procedure of war. Civilization protests against a step so retrograde. Surely comity among nations should be adequate to arrest it. If the League of Nations is vested with any real power, it should be possible for it to devise the means, and to ensure their successful application. The failure of the Hague Convention is no sufficient reason for despair. The moral sense of the civilized world is not so dulled but that, if roused, it can make its influence prevail. And steps should be taken without delay to make that influence supreme, and all the more so that there are agencies at work which would seek to perpetuate such methods as a recognized procedure of war. The case for what is called chemical warfare has not wanted for advocates. It is argued that poison gas is far less fatal and far less cruel than any other instrument of war. It has been stated that "amongst the 'mustard gas' casualties the deaths were less than 2 per cent., and when death did not ensue complete recovery generally ultimately resulted. . . . Other materials of chemical warfare in use at the Armistice do not kill at all; they produce casualties which, after six weeks in hospital, are discharged practically without permanent hurt." It has been argued that, as a method of conducting war, poison-gas is more humane than preventive medicine. Preventive medicine has increased the unit dimension of an army, free from epidemic and communicable disease, from 100,000 men to a million. "Preventive medicine has made it possible to maintain 20,000,000 men under arms and abnormally free from disease, and so provided greater scope for the killing activities of the other military weapons. . . . Whilst the surprise effects of chemical warfare aroused anger as being contrary to military tradition, they were minute compared with those of preventive medicine. The former slew its thousands, whilst the latter slew its millions and is still reaping the harvest." This argument carries no conviction. Poison gas is not merely contrary to European military tradition; it is repugnant to the right feeling of civilized humanity. It in no wise displaces or supplants existing instruments of war, but creates a new kind of weapon, of limitless power and deadliness. "Mustard gas" may be a comparatively innocuous product as lethal substances go. It certainly was not intended to be such by our enemies. Nor, presumably, were the Allies any more considerate when they retaliated with it. Its effects, indeed, were sufficiently terrible to destroy the German *morale*. The knowledge that the Allies were preparing to employ it to an almost boundless extent was one of the factors that determined our enemies to sue for the Armistice. But if poisonous chemicals are henceforth to be regarded as a regular means of offence in warfare, is it at all likely that their use will be confined to "mustard gas," or indeed to any other of the various substances which were employed up to the date of the Armistice? To one who, after the peace, inquired in Germany concerning the German methods of making

Menoher, chief. The aviator was Sergeant T. J. Fowler. The photographic equipment consisted of a mapping camera, K.1 model, fixed in the bottom of the plane. This camera is designed to take successive pictures automatically and can be so adjusted for the altitude of the plane and the apparent air speed that the exposures take a small overlap. The views can therefore be combined in a continuous mosaic. Theoretically the action should be perfect and the continuity of the pictures unbroken. In practise, the tilting of the plane is equivalent to turning a camera through a greater or less angle on a tripod and successive views may jump interspaces of greater or less extent. One remedy, with this type of camera, would be to repeat, a recourse which is practicable when flying over a restricted area, but impracticable in a flight between distant landing fields. A clinometer would enable the photographer to note the inclination of the plane and a finder might be used.

The flights here noted covered a course of approximately 400 miles each way and were made in 4 hours 40 minutes on the southward trip and 4 hours 13 minutes on the northward.

The San Andreas Rift, the object of observation, is that major continental structure which extends from Humboldt County in northern California to the Mohave Desert in the southern part of the state, a distance of about 600 miles. It is an ancient fault, the locus of innumerable movements, which have given rise to pronounced topographic features. Displacements have been upward or downward or lateral along different sections of the fault or during different movements along the same section. We have yet much to learn about the effects of faulting expressed in the details of geology along the rift.

The earthquake of April, 1906, produced marked surface features, which were carefully studied by Branner, Gilbert, Lawson and other geologists and which have been fully described in the report of the California State Earthquake Commission, publication 87 of the Carnegie Institution of Washington. One is often asked to what extent those features are still

"mustard gas," the reply was:— "Why are you worrying about this when you know perfectly well that this is not the gas we shall use in the next war?"

I hold no brief for preventive medicine, which is well able to fight its own case. I would only say that it is the legitimate business of preventive medicine to preserve by all known means the health of any body of men, however large or small, committed to its care. It is not to its discredit if, by knowledge and skill, the numbers so maintained run into millions instead of being limited to thousands. On the other hand, "an educated public opinion" will refuse to give credit to any body of scientific men who employ their talents in devising means to develop and perpetuate a mode of warfare which is abhorrent to the higher instincts of humanity.

This association, I trust, will set its face against the continued degradation of science in thus augmenting the horrors of war. It could have no loftier task than to use its great influence in arresting a course which is the very negation of civilization.

T. Edward Thorpe

AERIAL OBSERVATION OF EARTHQUAKE RIFTS

The Seismological Society of America is interested in mapping the earthquake rifts of California, with a view to increasing our knowledge of the structures related to earthquakes and to promoting security in the engineering work of the state. Data of a general and comprehensive character already exist in published and unpublished maps, but additional surveys are desirable. Faults may be located in several ways and it is possible that a method of tracing them may be developed with the airplane, as was first suggested to the writer by H. O. Wood. To test the idea, a flight was made by me from San Francisco to Los Angeles and return on June 9 and 11, so far as practicable over the San Andreas Rift, to observe and photograph it.

The plane was furnished by the Air Service of the U. S. Army, by courtesy of Major H. H. Arnold, under authority of General C. T.

visible and the answer is that much depends upon the climatic conditions of any selected section. Where rainfall is abundant, vegetation vigorous and erosion efficient, there is not much to be seen after fifteen years; but under arid conditions the marks of the disturbance of 1857 survive plainly.

The essential fact is that the Rift is a line, and features peculiar to it must fall into line. The general position and course of this Rift being known, the observer was constantly noting valleys, lakes and ponds, ravines, washes or scars on the surface, which lined up with one another. From over Mussel Rock, where the Rift cuts the shore, the range along the Rift was plainly that of the axis of San Andreas and Crystal Springs Lakes, and was continued in the valley through Searles Lake and beyond to Black Mountain. Stevens Creek heads in that summit on the Rift, and flows for six miles along it. Thus for a distance of 33 miles the earthquake line is marked by major features of the topography, by valleys which are due to the cooperation of displacement and erosion. Similar valleys might be produced by erosion alone, and since the rocks are hidden by water, soil and vegetation, the aerial observer could not see the displacement. In this section the observer could infer, but could not demonstrate the existence of the Rift.

Continuing southeastward beyond Wright's Station on the Santa Cruz branch of the Southern Pacific the Rift traverses the western slope of the Santa Cruz Mountains near the summit, and determines the course of numerous small valleys which are the head-valleys of streams that flow south to Monterey Bay, but which contrary to what would be expected, range themselves into line parallel with the crest of the mountains. Along this same line there are numerous landslide scars and small ponds. No one or small group of these features would necessarily indicate the existence of the Rift, but their alignment over a distance of 25 miles would be strong presumptive evidence of it, and that alignment can be seen from the airplane. The only other way in which it can be demonstrated is by a study of an accurate topographic map, which is in itself, as it were, an airplane view. Thus for any section of an earthquake track which might be indicated by features similar to those occurring on the western slopes of the Santa Cruz Mountains observation by airplane would constitute a valuable method of investigation.

Passing to the middle section of the earthquake Rift where the aridity of the climate prevents the growth of vegetation, and limits the destructive work of erosion, the marks of the earthquake became more distinct and more continuous. Thus my notes read: "Mustang Ridge and Peach Tree Valley, Rift shows in serpentine slides in the ridge. Temblor Range, the line of the Rift shows like a light soil streak for miles ahead. Over Carrizo Plains at Wolforts, Rift shows up in a line of white washes easily lined up," and a little further along: "Rift shows plainly like a canal ditch."

The ditch-like character of the Rift along the northeast slope of Carrizo Plain has been noted by Fairbanks and others. It is remarkable, plainly visible from an altitude of 12,000 feet, like a large empty irrigation canal. I could see it perhaps 10 miles ahead till it was lost in the rosy dust haze.

At this point the aviator passed me a note: "Forty minutes more gas." I scaled off the distance to Bakersfield, the only landing place. It was 35 minutes away and we turned from the Rift.

Returning from Los Angeles on the 11th we flew along the southeastern section of the Rift from Tejon Pass up Cuddy Valley to San Emidio Peak. In this stretch it is marked by springs which give rise to alkali patches or to green mallins, the marshes peculiar to seepages in arid valleys. Its features are easily traceable because of their linear continuity.

Photographing from an airplane is less satisfactory than observing. When the camera is fixed on the plane, as it must be to secure continuity of views, there is the trouble of swinging already referred to. I myself lost the sense of horizontal or vertical and was

quite unconscious of the fact that the camera was winking at the mountain slope when I thought it was photographing the lake.

In the vertical view features are flattened. This is true for vision and is even more pronouncedly true in photographs. It would be desirable therefore to observe during the earlier and later hours of the day when shadows are strong. The swiftness of flight makes this practicable, since miles become short when expressed in minutes and a distant field of study can be reached quickly. Photography, however, requires the strongest light possible because the exposure must be very brief when the camera is moving a hundred miles an hour, and this requirement limits the available hours to those when shadows are weak or lacking. The effect of this limitation is yet to be worked out, but since rift features are to a great extent relief features, it is of consequence.

So far as the trial flights of June 9 and 11 go they seem to demonstrate that aerial observation of a linear structural feature such as an earthquake rift is practicable. If one end of a rift be known it can be followed by a man skilled in the interpretation of topographic forms. Or if a line of features be detected, it may be so traced as to demonstrate their continuity and to facilitate the closer examination which may be necessary to prove the existence of a fault. I conclude that the airplane can be used to advantage as a means of rapid geologic reconaissance to map large structural features.

Bailey Willis

SCIENTIFIC EVENTS

INTERNATIONAL EXPLORATION OF THE UPPER AIR[1]

International exploration of the upper air dates from 1896, when a conference took place at Petrograd. Methods of sounding the atmosphere, even to a height of 23 miles, were devised. By the use of drifting free balloons, and recording instruments carried up by kites and anchored balloons, an unexpected stratification of the atmosphere has been discovered. The temperature falls regularly up to a height averaging six or seven miles from the ground, lower over the equator, higher near the poles. But the upper air is arranged in vertical columns in which the temperature is constant with height at any particular time and place. Little is known as to the cause of this disposition, and less as to the influence it must have on other factors of wind and weather. Useful knowledge can be gained only from data obtained by the same methods at the same times at the largest possible number of stations. International cooperation is necessary. It was interrupted by the war, although all the combatants made extensive use of the latest meteorological methods for the practical objects of artillery, aviation, poison gas, and sound-ranging. It has now been resumed. The other day we gave an account of the proceedings of the first meeting since the war, held at Bergen, in the last week of July, under the presidency of Professor V. Bjerknes. The name of that distinguished Norwegian meteorologist is associated with a new theory of the weather in temperate latitudes, on which we commented a year ago. The theory briefly is that just as the poles are capped with snow so they are capped by a great mass of cold air. In a wavering line round each temperate zone this polar air meets the warm air from the equator abruptly. Along the front of contact the warm air rises over the cold stream. Cyclones and anticyclones are born of the contest. The professor urges the formation of a closely set chain of observing stations round the globe in the zone of struggle. Other meteorologists are more disposed to assign the causes of our weather to the vaster regions of the upper air. An international meteorological committee, to meet in London in September, has been appointed by the Commission, and is to give special attention to the polar theory. The progress of its labors will be followed with deep interest. There are few human activities which would not gain by the advance of meteorological science, and the future of aviation will be largely determined by it.

[1] From the London *Times*.

THE WORLD'S SUPPLY OF WHEAT

According to a report issued to the Department of Agriculture prospects for the world's

wheat supply, while not so satisfactory as was expected during the first part of the current season, show at the present time no cause for serious alarm. Estimates of the quantity of wheat harvested in 20 countries, including the United States, for 1921, total 2,461,430,000 bushels, compared with 2,384,143,000 bushels harvested last year according to data compiled by the Bureau of Markets and Crop Estimates, United States Department of Agriculture.

The 20 countries included in this estimate are the United States, Canada, Argentina, Chile, Uruguay, Belgium, Bulgaria, Finland, France, Greece, Hungary, Italy, Spain, British India, Japan, Algeria, Tunis, Union of South Africa, Australia, and New Zealand. These countries produced approximately 68 per cent. of the known wheat crop of the world during the years 1903–1913, according to the annual average production records of the bureau.

Although the long-sustained drought throughout the greater part of the Northern Hemisphere was a serious menace to the various crops in many countries, the fall-sown wheat has not been affected adversely so much as was at first supposed. On the contrary, the fall-sown wheat managed to obtain a firm hold on the soil and a fairly vigorous growth before the beginning of the drought.

Nearly all of northern and central Europe will have larger wheat crops this year than last, according to the last estimates made by the bureau, Belgium and Greece being the only countries in which smaller crops are expected.

Outside of Europe, British India was most seriously affected by the drought. The dryness and the hot winds that have prevailed throughout most of the growing season have resulted in the very low yield 250,469,000 bushels of wheat, or about 50,000,000 bushels less than the quantity normally consumed in that country. With the rice crop also seriously affected, India is expected to import wheat this year instead of exporting it. In an average year before the World War, India exported over 50,000,000 bushels of wheat.

In Canada the total yield of spring wheat is estimated at 273,020,000 bushels, of which 264,137,000 bushels were grown in Saskatchewan, Manitoba, and Alberta. Fall wheat, grown almost exclusively in Ontario and Alberta, was estimated at 15,473,000 bushels. The total wheat yield of Canada for 1921 is therefore 288,493,000 bushels, compared with 263,189,000 bushels last year.

A very unsatisfactory feature in the present international situation is the hopeless condition of the Russian crops. Unofficial reports state that during last autumn and the spring of this year only a very small area was sown to the various crops, resulting in a failure to produce sufficient food for the country's needs. It is also reported unofficially that a considerable amount of wheat will yet be imported by Russia this year. But up to the present time the amount of wheat, as well as other foodstuffs, which will be imported is conjectural, and the Bureau of Markets and Crop Estimates is unable to make a definite statement concerning it.

In northern Africa, the wheat crop was generally larger than last year. In Algeria, thrashing results show a better yield than was expected earlier in the season. In Tunis, bad weather reduced the yields somewhat from those expected earlier, while in Morocco the crop was generally reported as satisfactory. According to estimates published by the International Institute of Agriculture at Rome, these three countries are expected to produce, for 1921, a yield of 66,138,000 bushels of wheat, compared with 36,743,000 bushels in 1920.

AN ENGLISH VIEW OF AMERICAN BIOLOGY

AT a recent meeting of the National Union of Scientific Workers in the Royal School of Mines, London, Sir Daniel Hall took the chair, and a lecture was given by Mr. W. B. Brierley head of the department of mycology at Rothamsted on "Personal Impressions of American Biological Research."

According to *Science Progress* Mr. Brierley opened by explaining that his visit to America was made primarily to attend the Phyto-

pathological Conference, which was peripatetic, ending at Lancaster, Ohio. By means of a sketch-map Mr. Brierley showed a complicated personal itinerary, from Quebec as a point of arrival, reaching to the southern limits of the United States, and including all the principal universities and biological stations. He then indicated the most striking and individual feature of American agriculture, which he described as the main source of wealth of the country. This was the almost complete concentration in wide areas of a single crop, so that there were 500 miles together of maize, of cotton, or of rice, and not much smaller areas of fruit or vegetables for preserving. One consequence of this was that plant disease ran riot through a whole area, and the field problems confronting the American agricultural biologist were so vast and menacing as almost to destroy the possibility of academic research, except in the eastern industrial regions, and to force the whole available scientific personnel into the field to stem a tide of disaster. In the industrial area, containing the older universities, the biological work approximated closely to that done in this country in subject and mode of attack, but in the state universities in the newer agricultural regions—each with its own single crop presenting urgent problems for solution—certain feaures were noticeable: (1) An early and extreme specialization, subjects which were here studied after a degree course in botany (such as plant pathology), being themselves degree courses, and the graduates, almost all of whom, from economic pressure on individuals and the crying need in the field, were unable to take post-graduate training, immediately devoting themselves exclusively to the study of a single type of disease. (2) There was almost no gradation between the academic biologist of real eminence and national or international reputation and the ordinary worker dealing with a limited field of applied science. For this reason the science on which their specialized practise was founded was apt to be too much in the background. Coming back, he felt Europe and England to be somewhat old, sophisticated, and contemptuous of youth. America is young, and has all the boundless energy of adolescence and its unique fervor.

Sir D. Hall, before opening the discussion, pointed out that America was not a country of farmers, but of industrialists working upon the land. Consequently they were less tied by tradition, and more ready to look to science for help. On the other hand, the state legislatures, which supported the biological work, were very apt to demand immediate results, and some promising work was spoiled by premature publication. England should take warning of the danger of allowing the legislature to get direct control of scientific research. He wecomed such a visit as Mr. Brierley's as a help towards counteracting the tendency in all civilized countries to erect quarantine walls against the entry of plants from abroad, for fear of disease. This fear was easily exploited by commercial firms for their own ends. The only way to get over the difficulty was to establish such mutual confidence between biologists in different countries as to render a guarantee of health given by the experts in any country absolutely trustworthy.

THE RETIREMENT OF DR. W. H. JORDAN

The faculty of Cornell University has adopted the following resolutions:

On the occasion of the retirement of Dr. Whitman Howard Jordan from the professorship of animal nutrition in Cornell University and from the directorship of the New York Agricultural Experiment Station at Geneva, the members of this faculty desire to record their appreciation of the inestimable service which Professor Jordan has rendered to science and to the scientific agriculture of the state and of the nation.

Professor Jordan assumed the directorship of the experiment station in 1896, a critical time for agriculture and for the new experiment stations. He brought to his work true scientific training, gained as an undergraduate student at the University of Maine, as a postgraduate student at Cornell University under the guidance of Professor Caldwell, and as an assistant to Dr. Atwater at the Connecticut Agricultural Experiment Station; and long experience as a teacher of agriculture and agricultural chemistry at the University of Maine

and at the Pennsylvania State College, and as director of the Maine Agricultural Experiment Station. With this wealth of training and experience, in addition to his high scientific ideals, his indomitable courage, his unflagging zeal for truth, his sound judgment in the selection of associates, and his unswerving loyalty to the best interests of agriculture, he has made a profound and lasting impression on the agriculture of this state.

The outstanding feature of his long service in the interest of agriculture has been his strict adherence to the dictates of science without regard to popular esteem or favor. Strong as the temptation has been for an administrator to popularize the work of his institution at the expense of its research, Professor Jordan, in his administration of the station, has held strictly to the original purpose and object of the institution uninfluenced by considerations of popular favor. Under his wise and capable administration, the New York Agricultural Experiment Station has attained a leading position among the agricultural experiment stations of the world.

Professor Jordan's connection with this college as professor of animal nutrition dates only from June 22, 1920, but his interest in the institution and his hearty and cordial cooperation have extended through all the twenty-five years that he has been director of the experiment station at Geneva. Accordingly there has always existed between these two institutions such close and gratifying cooperation in the prosecution of investigation and research that their work has ever been supplementary and unnecessary duplication of effort has been avoided.

In spite of all the multiplicity of duties which naturally come to an outstanding figure in agriculture, Professor Jordan has always found time to continue his own scholarly work in animal nutrition and to advise critically with members of his staff on a wide variety of highly technical subjects. His keenly analytical mind, his sound judgment, his unusual administrative ability, and, above all, his lofty personal ideals and breadth of vision, have endeared him to his colleagues and associates. He has richly earned the relief which retirement from active service brings, and we, his colleagues, wish him many years in which to enjoy the privileges of the contemplative life which is now his.

SCIENTIFIC NOTES AND NEWS

AT the recent Montreal meeting of the Society of Chemical Industry, Dr. Robert F. Ruttan, MacDonald professor of chemistry at McGill University, was elected president in succession to Sir William Pope.

THE University of Edinburgh has conferred the degree of doctor of laws on Dr. Irving Langmuir, of the research laboratory of the General Electric Company, Schenectady, who at the meeting of the British Association in that city opened the discussion on "The Structure of Molecules."

PROFESSOR EDWARD W. BERRY, of the Johns Hopkins University, has been elected a fellow of the American Academy of Arts and Sciences.

DR. JAMES M. ANDERS has been elected president of the American Therapeutic Society for the ensuing year. Dr. Anders was also recently elected president of the American College of Physicans.

BARON R. VON HÜGEL has resigned the curatorship of the Museum of Archeology and Ethnology of the University of Cambridge and Dr. A. C. Haddon, Christ's College, has been appointed deputy curator.

THOMAS FORSYTH HUNT, dean of the college of agriculture, University of California, has resumed his office after a year's stay in Europe, spent in part at Rome as the delegate of the United States to the International Institute of Agriculture.

HARRY D. KITSON, professor of psychology at Indiana University, has returned from Europe where he conferred with investigators in industrial psychology in England, France, Germany and Switzerland.

PROFESSOR WILLIAM S. COOPER, of the University of Minnesota, is making a study of the recession of the Muir Glacier at Glacier Bay, Alaska.

MR. MONTAGUE FREE, horticulturist and head gardener of the Brooklyn Botanic Garden, returned recently from England where he visited Kew and various other public and private gardens. In the course of the trip,

Mr. Free secured many valuable seeds and living plants in exchange for similar material from the Brooklyn Botanic Garden.

We learn from *Nature* that Mr. B. A. Keen, head of the soil physics department, Rothamsted Experimental Station, has been awarded a traveling fellowship by the Ministry of Agriculture. He has come to America to inspect general agricultural conditions with special reference to problems on soil cultivation.

Dr. Ma Saw Sa, head of the Lady Dufferin Hospital, Rangoon, Burma, has come to the United States to continue the study of medicine at Johns Hopkins University, Baltimore.

A statue of Dr. Enrique Nuñez has been erected at the entrance to the grounds of the Garcia Hospital at Havana, the construction of which was due to his initiative. He was long chief of the national public health service.

An oil portrait of the late Senator Judson H. Morrill, which for many years hung in his Washington home, has been presented to the University of Vermont, and has been placed in Morrill Hall.

The Experiment Station Record announces the death on July 5, at the age of seventy-eight years, of John Hamilton, formerly professor of agriculture in the Pennsylvania State College, and of Jacob H. Arnold, agriculturist in the Office of Farm Management and Farm Economics, of the U. S. Department of Agriculture, who died on July 12, at the age of fifty-seven years.

Professor Henri Beaunis, known for his work on physiological psychology and hypnotism at Mercy and later at Paris, has died at the age of ninety-one years.

The 1921 volume of the Summarized Proceedings of the American Association for the Advancement of Science, the publication of which has been greatly delayed owing to the printers' strike, will soon be issued from the office of the permanent secretary of the association. This volume contains the old and the new constitution, the lists of officers, and references to Science for the reports of the Pacific Coast meeting (summer of 1915), the Columbus meeting (1916), the New York meeting (1917), the Pittsburgh meeting (1918), the Baltimore meeting (1919), the St. Louis meeting (1920), and the Chicago meeting (1921). It also contains the complete list of members of the association, corrected to June 15, 1921. Members who have already ordered the volume will be sent copies as soon as the book is published; and those who have not ordered the volume may still do so, the price being two dollars, payable when the order is placed. The price to others is two dollars and fifty cents. The new list constitutes a directory containing the names, degrees, positions, addresses, etc., of about 12,000 scientific workers and others interested in scientific progress. It has been prepared from data obtained through special information blanks sent to all members.

The Société de Chimie Industrielle will hold a congress in Paris in October. There will be thirty-four sections representing the various applications of chemistry and some valuable discussions are anticipated. A reception of the members will take place on the evening of October 9, and the opening meeting will be held on the following day, under the presidency of Monsieur Dior, Minister of Commerce. On October 11 the Minister of Agriculture will occupy the chair at a banquet in the Palais d'Orsay. A number of works will be visited and an exhibition is being organized in connection with the congress.

The board of trustees of The Ohio State University has authorized the establishment, within the college of agriculture, of the plant institute of the Ohio State University. All members of the staff of the college interested in plant studies may be members, and all graduate students doing their major work with plants are associate members. The institute will conduct a seminary, review the work of its graduate students and encourage research, especially the study of such problems as require cooperation. The departments of the college chiefly concerned are: Botany, Horticulture, Farm Crops, Agricultural Chemistry and Soils.

THE Connecticut legislature has increased the biennial appropriation for the State Experiment Station from $45,000 to $82,000. It has also appropriated $10,000 for investigations on matters connected with the production of tobacco. The station has secured a field of about 13 acres where experimental work may be carried on along this line.

ACCORDING to the *Journal* of the American Medical Association a new hospital group, designed to be one of the largest and most up to date in the country and incorporating the University Hospital, the nurses' home and the schools of medicine, dentistry and pharmacy in a single system, is to be erected by the University of Maryland at Lombard and Green streets, Baltimore. The main building will be eleven stories in height with a roof garden above. Plans call for a hospital of 300 beds, and ultimate expansion to 500 is contemplated. The nurses' home is planned to furnish accommodations for 200, with facilities for 300 students in the combined schools. The cost is estimated at about $1,250,000. When the project is fully developed, a unique feature will be an arrangement by which the most modern adjuncts of medical science will be placed at the disposal of rural practitioners through graduate and extension courses. It is planned to have traveling instructors, who will hold courses in rural communities and also to give the rural practitioner the opportunity to bring all special cases to the hospital. The institution will offer the medical practitioner the service which the agricultural college of the university now provides for the farmer. One of the principal objects of the enlarged institution will be to relieve the city's inadequate hospital facilities. Construction of the first portion of the group will be begun within the month and will cost approximately $250,000 when completed; erection of the second unit of the home is expected in about a year. The whole project will require several years for its development. The University Hospital was opened in 1823 under the name of the Baltimore Infirmary, and has been enlarged fourfold by successive additions.

THE San Diego museum has been presented with a library of ancient and modern manuscripts and books treating Chinese art, by Dr. William P. Gates, one of the founders of the institution.

Nature states that in consequence of the retirement of Sir Hercules Read, the department of the British Museum hitherto known as the Department of British and Medieval Antiquities and Ethnography has been divided, and the following appointments have been made by the principal trustees: Mr. O. M. Dalton to be keeper of the Department of British and Medieval Antiquities; Mr. R. I. Hobson to be keeper of the Department of Ceramics and Ethnography; Mr. T. A. Joyce to be deputy-keeper in the Department of Ceramics and Ethnography. Mr. Reginald Smith, hitherto deputy-keeper in the undivided department, becomes deputy-keeper in the Department of British and Medieval Antiquities. The prehistoric collections fall into the Department of British and Medieval Antiquities, and the Oriental collections into that of Ceramics and Ethnography.

UNIVERSITY AND EDUCATIONAL NEWS

TRINITY COLLEGE will receive a contribution of $125,000 to its centennial fund from the General Education Board.

THE *Experiment Station Record* reports that a fund to be known as the A. D. Watson prize fund is being collected by subscription at the University of Minnesota in honor of the retiring director of extension work. The income of this fund is to be used annually in either the college or school of agriculture or both as prizes to students excelling in studies having to do with cooperation and cooperative enterprises.

AT the recent meeting of the State Board of Agriculture, the resignation of Dr. F. S. Kedzie as president of the Michigan Agricultural College, effective on August 31, was accepted, and he was appointed dean of the Division of Applied Sciences. Professor David Friday of the department of economics of the University of Michigan was appointed

president, effective on January 1, 1922. R. S. Shaw, dean of the Division of Agriculture, was appointed acting president for the interim.

D. T. Gray, chief in animal industry in the North Carolina Agricultural College and station, has been appointed director of the Alabama station, succeeding J. F. Duggar, director since 1903, who retires to become consulting agriculturist.

Dr. Olof Larsell, former associate professor at Northwestern University Medical School, Chicago, has been appointed professor of anatomy at the University of Oregon Medical School.

Dr. J. P. Baumberger has been promoted to an assistant professorship of physiology at Stanford University.

Dr. F. C. Vilbrandt, of the Ohio State University, has been appointed associate professor of industrial chemistry of the University of North Carolina.

DISCUSSION AND CORRESPONDENCE

DISCOVERY OF SAUROPOD DINOSAUR REMAINS IN THE UPPER CRETACEOUS OF NEW MEXICO

In a small collection of vertebrate fossils recently received at the U. S. National Museum, from Mr. John B. Reeside, Jr., geologist of the U. S. Geological Survey, was an almost complete left scapula of a large Sauropodous dinosaur. The importance of this particular specimen lies in the fact that it was collected by Mr. Reeside in the Ojo Alamo formation, Upper Cretaceous, as developed in the San Juan Basin in northern New Mexico. Since the remains of Sauropodous dinosaurs have not been known before above the early Lower Cretaceous in North America, the extension of their geological range into the Upper Cretaceous, as indicated by the present discovery, is of the greatest interest.

The close general resemblance of this bone to the described scapulæ of the Sauropoda from Morrison formation, its great size (five feet in length), and the fairly good state of preservation, precludes the possibility of mistaken identification, and the determination of its geological occurrence by a geologist of the acknowledged ability of Mr. Reeside, who has an intimate acquaintance with the geological structures and succession of formations in the San Juan Basin, due to two field seasons spent in the area, places the determination of the geological position of the specimen beyond all question of doubt.

This preliminary announcement will be followed by a more detailed account of the specimen when its preparation now in progress is completed.

Charles W. Gilmore
U. S. National Museum,
August 16, 1921

LEAF STRIPE DISEASE OF SUGAR CANE IN THE PHILIPPINES

In early 1920, a firm of Japanese sugar-cane growers introduced cane points of Formosan cane varieties for use on their plantation in Rizal Province, Luzon. The sugar-cane points, according to the Japanese firm, had been grown by the Experiment Station of the Japanese Government in Formosa. On arrival at the port of Manila, the shipment was intercepted by the Philippine plant quarantine inspectors, but the Japanese growers prevailed upon the too-lenient government official to allow them to bring in the cane, after dipping it in Bordeaux mixture.

Upon the appointment of the writers to the plant disease laboratories in March, 1920, they became cognizant of these circumstances, and since then, periodical inspections of the planting have been made. In April, 1921, the cane having been ratooned numerous cases of etiolation of the young plants were observed. Such light-colored plants were very conspicuous and could be observed at a considerable distance from the field.

On the lower surface of affected leaves, a white spore mass was abundant; the pathological condition was of course immediately suggestive of downy mildew of the sugar cane. Examination of the fungus evidenced the presence of a *Sclerospora* species. This pathological condition could not be found on

fields of native cane adjacent to, and surrounding, the field of Formosan cane. According to Dr. W. H. Weston,[1] the morphology of *Sclerospora philippinensis* is very nearly identical to that of *S. sacchari*. However, he states:

> In the Philippines, in regions heavily infected with the maize mildew, sugar cane fields comprising many varieties grown under widely varying conditions and situated adjacent to the badly infected maize, and even containing some maize plants growing among and in contact with the young cane, have been under frequent observation during all stages of their development for over a year, and yet no case of infection with the downy mildew of maize has ever been seen.

He was, moreover, unable to cross-inoculate *S. philippinensis* from corn to sugar cane. The evidence is therefore strongly suggestive of the importation of the sugar-cane downy mildew, *Sclerospora sacchari* T. Miyaki, from Formosa.

The only literature on this disease which we have available here is the above-mentioned publication by Dr. Weston on the Philippine corn mildew, which incidentally discusses the cane mildew.

Measures have been taken to plow up the affected field, burn the affected stubble, and fallow the land. Steps to trace seed cane that emanated from the field are also under way, and it is possible that the disease may be entirely eradicated in the Philippines. The present brief note is presented as of possible interest to agronomists and plant quarantine officials of western countries. The importation of this disease and the recent experience in the Philippines with the introduction of Fiji disease of cane are two excellent examples of the need for rigid enforcement of plant quarantine regulations.

H. ATHERTON LEE,
MARIANO G. MEDALLA

PLANT DISEASE LABORATORIES,
BUREAU OF SCIENCE AND
BUREAU OF AGRICULTURE,
MANILA

[1] Weston, W. H., "Philippine downy mildew of maize," *Jour. Agr. Res.*, XIV., No. 3, p. 97.

ENGLISH PRONUNCIATION FOR THE METRIC SYSTEM

TO THE EDITOR OF SCIENCE: May I add a word of approval to what Dr. Frost has said in *re* (SCIENCE, May 13, 1921) "English Pronunciation for the Metric System" and suggest that the word ki'lo-me'ter should be pronounced with the accent upon the first and third syllables. In some quarters it is pronounced kilo'm-eter, contrary to the more general usage. This pronunciation, however, follows the custom in the case of thermo'meter, which is a much older word.

THADDEUS L. BOLTON

THE TEMPLE UNIVERSITY,
PHILADELPHIA

GREGOR MENDEL AND THE SUPPORT OF SCIENTIFIC WORK AT BRUNN

TO THE EDITOR OF SCIENCE: Under date of December 29, 1920, I received a letter from Dr. Hugo Iltis of Brünn, Czechoslovakia, of which the following paragraphs are extracts:

> The venerable old "Naturforschende Verein" of Brünn runs the risk of stopping scientific work for want of money. For the same reason our university extension work is cut short. In this condition of utter distress I apply to your kindness and ask you to help us. Wealthy friends of Mendelism could perhaps be induced to grant us the means to continue our scientific and popular education-work. If it would be possible to get an assistance of one thousand dollars for each of the two institutions, the "Naturforschende Verein," where Mendelism took its origin, and "University Extension of Brünn," where work has just begun, would be saved for the next two or three years.
>
> When we published the Mendel-festival-volume, science and art flourished, and we tried by our work to prove worthy of Gregor Mendel. Now we have become so poor that we can not buy any scientific literature, nor can we have scientific treatises printed. We have made up our minds to sell our most precious treasure, the original manuscript of Gregor Mendel's most renowned work, "Versuche über Pflanzenhybriden," and I ask you to lend us your kind assistance in this matter too. Perhaps it could be sold by auc-

tion with the lowest bid of $6,000. This sum would afford us the chance of buying a small house as a refuge for our collections and library, which are in constant danger of being burned out.

It seems to me that all who appreciate the importance of Mendel's contribution should be actively interested in this message. Just what can and should be done and how to go about it are matters for discussion. I would suggest that those interested express their views in the columns of SCIENCE. However, some may wish to communicate directly with Dr. Iltis. His local address is Bäckergasse 10, Brünn, Tschechoslwakei.

E. B. BABCOCK

NOTES ON METEOROLOGY AND CLIMATOLOGY

DETERMINING THE TRUE MEAN TEMPERATURE

WHAT is the true mean temperature? It is a much easier task to define the true mean temperature than to determine it, but the prosecution of meteorological and climatological work demands that this element be determined. A very detailed and thorough discussion of the question has been published by Mr. C. E. P. Brooks, of the British Meteorological Office, in the *Monthly Weather Review*,[1] and it is of interest to review the varied nature of the problem and the solutions offered.

The "true mean temperature" is the mean height of a thermograph trace corrected for any sources of instrumental error. In practise, however, the mean of twenty-four hourly observations, or even the mean of observations every two, three, or four hours, is sufficiently close to yield the daily mean temperature. But it is not always feasible to secure such frequent observations, and the problem of reconstructing the true mean from three observations daily and the maximum and minimum faces the meteorologist. There are four ways of accomplishing this:

First, the combination of the means of the three daily observations at fixed hours, or the maximum and minimum, in proportions that have been found to be satisfactory at certain standard stations. If observations at 7 A.M., 1 or 2 P.M., and 9 P.M. be designated by *I*, *II*, and *III*, respectively, and the true mean by *T*, it is found that

$$T = (I + II + 2 \times III)/4$$

gives the best results, in general; but, in Greenland, where the morning observation occurs at 8 A.M., the formula commonly used is

$$T = [2(I + II) + 5 \times III]/9.$$

The author carried out an investigation of this type of formula by the method of least squares, for various groups of stations, such as western Europe, subtropics, and tropics, and found that for the first the usual one (given above) gave the best results; for the subtropics, the best combination is

$$T = [I + II + III - 1/10(II - III)]/3;$$

and for the tropics, this last can be used, although it is not as accurate for the tropics as for the subtropics. An alternative formula which gave very satisfactory results for Batavia is

$$T = [2(I + II) + 3 \times III]/7.$$

These apply, of course, to the hours specified above. It is further pointed out that the maximum and minimum can be combined into such formulæ, instead of the three observations, and examples are given for Hamburg, in which the maximum and minimum are combined with the morning and evening observations; and for Tunis and Egyptian stations in which the minimum only was combined with the three daily observations.

Second, "the calculation of appropriate additive corrections for various combinations of hours or for the mean of the maximum and minimum at standard stations, and their transference without modification to other stations in the vicinity." This method is only applicable to those stations or regions where the conditions are similar, such as are to be found in Russia and Siberia, or in the eastern half of the United States. The method is to plot the corrections for standard stations and to read off for the intermediate stations the appropriate correction. In mountainous districts, such as western United States, or the mountains of India, this scheme is unsatis-

[1] April, 1921, pp. 226–229.

factory. A combination of this method with the first one above is often helpful, and has been used in Chile.

Third, "the corrections at the standard station may be multiplied by a factor proportional to the daily range (or to the difference between midday and evening observations) at the station to be corrected." This method depends upon properly correcting for any difference in daily range which may exist between nearby stations, as, for instance, between hill and valley stations where the daily ranges may be quite different. But care must be used to see that the climates of the two places are similar, for the daily amplitude of variation may be the same, but the shape of the curve different. This was found to be the case in applying the method to Los Andes (valley) and Santiago (coastal slope), Chile, in which the amplitude is the same but the sharp night minimum at Los Andes was markedly different from that at Santiago.

The fourth, and last, method is that in which "all direct use of standard stations may be avoided and the reduction to true mean based on considerations connected with the general phenomena of the diurnal variation of temperature." This makes no use of standard stations but bases the whole system upon a normal diurnal curve which may be expressed by the Fourier series

$$T_h = T + a_1 \sin (t_h + A_1) + a_2 \sin (2t_h + A_2),$$

in which the coefficients of the first and second harmonics may be calculated as follows:

$$a_1 = -0.72 + 0.44 (M - m),$$
$$a_2 = +0.54 + 0.08 (M - m).$$

This method has been thoroughly tested and has given satisfactory results, but is chiefly valuable when the stations are so situated that the other methods are not applicable.

A. Buchan favored the mean of the daily maximum and minimum as the most satisfactory expression of true mean temperature, and the view has become widely accepted. But there are objections, not only from the instrumental standpoint—for maximum and minimum thermometers are more likely to develop systematic errors than are dry-bulb thermometers—but also because the ratio of this mean to the true mean is dependent upon location, time of year, and cloudiness. For that reason, the author advises meteorologists in English-speaking countries to make less use of the mean of the daily extremes and more of suitable combinations of the observations at fixed hours, such as the first formula above.

C. LEROY MEISINGER

WASHINGTON, D. C.

SPECIAL ARTICLES

ON THE ELIMINATION OF THE X-CHROMOSOME FROM THE EGG OF DROSOPHILA MELANOGASTER BY X-RAYS

SOME of the results of the investigation of the biological effects of X-rays point to a specific effect of the rays on the nuclear matter of the dividing cell and especialy the germ cell.

1. Actively growing tissue whether normal or pathological is the most susceptible to X-rays.

2. It has been found comparatively easy to sterilize a number of different species without apparently otherwise injuring them.

3. Perthes[1] has found that X-rays have a destructive effect on chromosomes in the ova of *Ascaris megalcephala.*

The experiments to be described were performed with a view to determining if X-rays by affecting the X-chromosome could disturb the inheritance of a sex-linked character. Wild type (red-eyed) females of *Drosophila melanogaster,* homozygous for red-eye, were X-rayed soon after emerging from the pupa with a dose just under the sterilization dose and mated to white-eyed males. Sisters of the rayed females were used as controls and mated to white-eyed males. The white eye color is sex-linked and recessive to the red and when there is no non-disjunction the offspring in tht first generation of a cross between a homozygous red-eyed female and a white-eyed male are all red-eyed.

In all, four experiments have been performed. In three of these, numbers 71, 76, and 77, thirty-five virgin females, homozygous for

[1] Perthes, *Deut. Med. Woch.,* 30, 1904.

the red-eyed character, were mated with white-eyed males. Nineteen of these were used as controls and sixteen were X-rayed soon after emerging from the pupa and immediately before mating. The rayed females were the sisters of the controls. *None of the nineteen control pairs produced white-eyed males.* One of the rayed females was sterile. *Of the fifteen fertile rayed females, twelve produced one or more white-eyed males.* The total number of offspring in the first generation produced by the control pairs was 6579 (3367 ♂, 3212 ♀) all red-eyed, and by the pairs in which the females were rayed it was 2460 (1227 red-eyed ♂, 1211 red-eyed ♀, 20 white-eyed ♂ and 2 gynandromorphs). In the fourth experiment seven wild-type sister females were used, three were kept as controls and four were rayed. All were mated with white-eyed males. One of the control females produced one white-eyed male. Two of the three rayed females produced white-eyed males, one producing three and the other one.

In the first and fourth experiments the white-eyed males were also homozygous for the character, "dumpy," which is located in the second chromosome. Of the six white-eyed males produced in these experiments five had normal wings and the other died before its wings expanded.

Twenty-three out of the twenty-four exceptional white-eyed males came from eggs which were laid during the first six days after raying and mating. The other male came from an egg probably laid on the seventh day after raying. Further the exceptional white-eyed males divide themselves into two groups corresponding to eggs laid during the earlier part and the later part of this six day period.

That the presence of these white-eyed males could be due to natural non-disjunction and not to any effect of the X-rays seems extremely unlikely from the following considerations: In experiment 71, out of 7 fertile sisters the two which were X-rayed produced white-eyed males. The chance in a random picking of getting a particular two out of seven can be shown to be 1 in 42. We may add the results of experiments 76 and 77 since the females used in these experiments were all the offspring taken at random of two pairs. If the result here was not due to X-rays, then in taking at random 12 females from 26 for raying we must have taken the only 10 which produced white-eyed flies. The chance of doing this can be shown to be 1 in 9,600,000 tries.

Since the white-eyed males produced by the X-rayed females when crossed to white-eyed dumpy males were normal winged, the second chromosome of the female can not have been affected to the extent of the elimination of the gene for normal wing.

It may be stated that a repetition of these experiments is in progress and that a number of experiments have already been carried far enough to confirm the earlier findings.

In order to determine whether the whole or a part of the X-chromosome is affected by the X-rays, two strains with sex-linked characters have been used, both obtained through the kindness of H. H. Plough—an eosin-miniature stock and a scute-echinus-cut-vermilion-garnet-forked stock. Males of both of these stocks have been used in experiments similar to those described. In all cases so far the exceptional males produced by the X-rayed females (the control females have produced no exceptional males) have all the sex-linked characters.

Since the eggs which have produced the exceptional white-eyed males were probably rayed either 2 to 3 or 5 to 7 days before laying, there seems reason to believe that they were acted on by the X-rays while preparing for one of the maturation divisions. (Compare here the work of H. H. Plough, 1917, on the effect of temperature on crossing over.)

We know from the work of Stevens[2] and Metz[3] that the X-chromosomes of *Drosophila melanogaster* (*ampelophila*) behave, in the male, differently from the other chromosomes in the maturation divisions. If, as seems probable, the chromosomes during division go through a stage in which they are particularly susceptible to X-rays, then it would seem

[2] Stevens, *Proc. VII. International Zool. Cong.*, 1907.

[3] Metz, *Journ. Exp. Zool.*, 1914.

probable that the X-chromosomes may pass through that stage at a time different from that at which the other chromosomes pass. This would account for the production of the exceptional white-eyed males in the experiments if we consider that the X-rays were applied to the particular germ cell at a time when only the X-chromosome was in a condition suceptible to the dose given.

The writer wishes to express his great indebtedness to Dr. Willis R. Whitney, director of the Research Laboratory of the General Electric Company at whose suggestion work on fruit-flies was undertaken and without whose cooperation it could hardly have been done. He is also indebted to Mr. O. J. Irish for accurate and careful work as technical assistant throughout the investigation.

JAMES W. MAVOR

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EPIDEMIC PNEUMONIA IN REPTILES

DURING the spring and early summer months of 1919 there occurred an epidemic among the reptiles kept in captivity in the Bronx Zoological Gardens which resulted in the death of many of them.

The clinical course of this disease, if it may be considered the same disease in all, was difficult to follow on account of the well-known sluggishness of these animals, which often remain quiet for a long time and fail to eat anything. For this reason the attention of the caretakers was seldom attracted to sick animals until they were found dead. In some cases, however, it was observed that they suffered from an intense dyspnœa and held their mouths open in the effort to breathe. Others emitted a frothy, slimy exudate from the mouth and nostrils. Even then it was difficult to observe any other symptoms and the attempt to secure a series of observations on the temperature of the sick animals for comparison with that of several normal ones of the same sort could not be carried out successfully.

A great number of those which died were sent to the laboratory for autopsy and it is interesting that several turtles sent from the New York Aquarium were found to have died from the same disease. Careful autopsies were made upon all these animals and cultures and smears taken from the lungs and upper respiratory tract and usually also from the heart's blood. Other snakes and some rabbits, rats and mice were inoculated with the cultures derived from these cases.

Cases of pneumonia were studied at autopsy in the following animals, often in many individuals of the same species: *Iguana tuberculata, Zamenis lamelliformis* (Texas rattlesnake), *Trachyurus rugosus* (stump-tailed lizard), *Crotalus atrox* (Florida rattlesnake), *Ancistrodon contortrix* (copperhead), *Varanus gouldi* (Australian monitor), *Spilotes corais* (blacksnake), *Tupinambis teguexin* (yellow tegu), *Pityophis sayi* (bull snake), *Alligator mississippiensis, Anaconda, Chelonia imbricata* (hawksbill turtle), *Eutænia sirtalis* (garter snake), *Coluber guttatus, Thalassochelys caretta* (loggerhead turtle), *Heloderma suspectum* (gila monster), *Ophibolus getulus* (king snake), *Chrysemys elegans* (Cumberland turtle), *Chrysemys picta* (painted turtle), *Tropidonotus fasciatus* (water snake), *Heterodon platyrrhinus,* and *Zamenis flagelliformis.*

The autopsies on these animals as a rule revealed a partial consolidation of the tubular spongy lung, various diverticula of the main bronchial cavity with their air cells being filled with an opaque blood-stained grayish exudate with occasional hæmorrhages in the surrounding tissue. In one instance (*Varanus*) there was also an acute pericarditis with yellowish effusion upon the surface of the heart.

Smears from the consolidated portions of such lungs showed the presence of great numbers of rather small gram negative bacilli, sometimes with a slight admixture of gram positive diplococcoid organisms but usually in practically pure culture.

Microscopically, the condition was fairly uniform in all. In *Crotalus atrox* many of the wide air cells were distended with compact masses of cellular exudate composed chiefly of leucocytes which are large with round vesic-

ular nucleus and indefinite granules. There were many red corpuscles and more especially nuclei of laked red corpuscles mingled with these, but little fibrin. In this exudate and especially in the crevices between masses of exudate great clouds of gram negative bacilli could be seen. The same description applies to the lungs of *Ancistrodon, Zamenis, Pityophis, Chelonia imbricata,* et cetera.

The lungs of the anacondas presented a slightly different appearance, for the gram negative bacilli tend to be collected in masses in the alveoli and densely surrounded by leucocytes and red corpuscles in a disintegrated condition so as to form round balls. The large leucocytes are filled with conspicuous granules which stain purple with the Gram stain and with Wright's stain and are probably to be regarded as basophilic granules.

So, too, the lungs of *Tupinambis teguexin* showed round nodules or masses of cells clustered round a central clump of gram negative bacilli.

In the lungs of *Heloderma* the exudate in the alveoli was composed of a dense pink staining granular coagulated material with abundant clumps of gram negative bacilli usually enclosed in phagocytes.

The lung of *Chrysemys picta* presented a dense exudate of closely packed leucocytes with nuclei of red corpuscles and with great numbers of diffusely scattered gram negative bacilli. In this case the alveolar walls were much thickened and infiltrated with fluid and with leucocytes.

No especial alteration of the bronchial walls nor of the coarser supporting tissue of the lungs could be observed. The abdominal organs were in all cases apparently normal, and as a rule the animals were in a good state of nutrition.

Cultures made from heart's blood and lungs gave in practically every case luxuriant growths of a small gram negative bacillus when incubated at 23° C. Only in the case of *Thalassochelys Caretta* and one alligator were the bacilli somewhat larger.

Five of these strains were grown in broths containing various sugars for comparison with results shown in the following table.

Growth produced sediment in all tubes except those with maltose inoculated with 2 and 4 where there was pellicle formation.

From the above table it will be seen that Nos. 1 and 3 agree in acid and gas formation when grown in the specified sugars, while 2, 4 and 5 differ among themselves and also differ from 1 and 3 in their powers of sugar fermentation and gas formation. When grown on gelatin liquefaction was produced by 4 and 5 but not by 1, 2 and 3. 4 also produced gas.

From several normal garter snakes studied as controls the cultures of heart's blood and lungs were sterile except in two cases in which occasional colonies of a quite different thick gram negative bacillus were found.

A rabbit was immunized with four injections of culture 4, and eight days after the last injection the serum of this rabbit agglutinated the homologous strain completely in a dilution of 1–60 but showed no agglutination with nine other strains.

Intratracheal injections of cultures 4 and 6 were made in garter snakes and two species of *Chrysemys* and were followed by pneumonia exactly resembling that in the animals from which the cultures were taken. The

	Maltose		Levulose		Dextrose		Xylose		Saccharose		Lactose		Mannit	
	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas	Acid	Gas
1	++	+	++	+	++	+	++	+	0	0	0	0	++	++
2	++	0	++	0	++	0	0	0	++	0	0	0	++	0
3	++	+	++	+	++	+	++	+	0	0	0	0	++	+
4	0	0	++	0	++	0	0	0	0	0	0	0	++	0
5	++	+	++	+	++	+	++	+	++	+	0	+	++	+

organism was recovered in pure culture from the lungs of these inoculated animals. The bacillus is also highly virulent for rabbits, killing them often within twenty-four hours.

No exact identification of the organism or organisms concerned in this epidemic can be offered, although in general they are very closely related to the rabbit septicæmia group. The bacteriological studies, for which I am greatly indebted to Mrs. Julia T. Parker, were not carried to completion but they show that although the gram negative bacilli found in all the cases were morphologically identical, they differed somewhat in their fermentation reactions and did not, except in the case of the homologous strain, agglutinate with the one specific serum produced in a rabbit. The latter result may be because of an unfortunate choice of one aberrant strain for the production of the serum or it may be because the various strains occurred in different species of reptile.

Since this was a well-defined epidemic of pneumonia affecting a variety of reptiles it seems probable that the original infecting organism may have acquired slightly different biological characters in its growth in different species.

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THE OHIO ACADEMY OF SCIENCE

THE thirty-first annual meeting of the Ohio Academy of Science was held at Western Reserve University and Case School of Applied Science, Cleveland, March 25 and 26, 1921, under the presidency of Mr. W. H. Alexander, of the United States Weather Bureau, Columbus. Fifty-nine members were registered as in attendance; forty-seven new members were elected.

An excursion, organized in connection with the meeting, was carried out by the Section for Geology on May 28, 29, and 30. The itinerary (Wilmington, Clarksville, Fort Ancient, Oregonia, Dayton) was planned for the study of the Richmond formations of southwestern Ohio. The party of fifteen geologists was under the guidance of Drs. August Foerste and W. H. Shideler.

The trustees reported a gift of two hundred and fifty dollars from Mr. Emerson McMillin, of New York City, in furtherance of the research work of the Academy.

The death of one member was reported: Mr. Thomas Piwonka, of Cleveland. Mr. Piwonka was born of Bohemian stock in New York City, September 10, 1854; he died May 9, 1920. His membership in the Academy began in 1893. The obituary notice, prepared by Professor J. E. Hyde, closes with these words: "His life work was law, but in spare moments he was a naturalist with particular interest in geology, botany and microscopy. His passing removes one more (very few are left!) of that generation of men interested in the natural history of their locality, with the collector's keen instinct, to which paleontology is profoundly indebted. With them is passing a phase of our culture."

Another of the older members of the academy, Professor G. Frederick Wright, of Oberlin, died on April 20, less than a month after the meeting. His name appears on the program; but he was too ill to be present, and the paper was read by another. He had been a member since 1892.

Officers were elected as follows: *President*, R. C. Osburn, Ohio State University; *Vice-presidents:* Zoology, J. E. Kindred, Western Reserve University; Botany, E. N. Transeau, Ohio State University; Geology, J. E. Hyde, Western Reserve University; Physics, W. G. Hormell, Ohio Wesleyan University; Medical Sciences, F. C. Waite, Western Reserve University; Psychology, Rudolph Pintner, Ohio State University (since removed to Teachers College, Columbia University); *Secretary*, E. L. Rice, Ohio Wesleyan University; *Treasurer*, A. E. Waller, Ohio State University.

The scientific program was as follows:

PRESIDENTIAL ADDRESS

Thunderstorms: especially those of Ohio: Mr. W. H. ALEXANDER, U. S. Weather Bureau, Columbus.

PUBLIC LECTURES

Hookworm and human efficiency: PROFESSOR CHARLES A. KOFOID, University of California.

Scientific work at the Ohio Bureau of Juvenile Research: DR. HENRY H. GODDARD, Ohio Bureau of Juvenile Research, Columbus.

PAPERS

The new Cleveland Museum of Natural History: PAUL M. REA.

The state park situation in Ohio: J. ERNEST CARMAN.

Chronological view of men of science: J. A. CULLER.

A peculiar case of stature inheritance: A. B. PLOWMAN.
A differential sensitivity theory of time and space and its bearing on evolution: L. B. WALTON.
The relation of the biologist to public health administration: A. B. PLOWMAN.
The function of the striæ and the origin of bilateral symmetry in the euglenoids: L. B. WALTON.
The geographical distribution of the genera of the Opalinidæ: MAYNARD M. METCALF.
Hemiptera of the Adirondacks: HERBERT OSBORN.
Collecting in southern Florida: HERBERT OSBORN.
Some studies in Hessian fly emergence: T. H. PARKS.
Notes on the habits and life history of Galeatus peckhami Ashm.: CARL J. DRAKE.
A new Ambrosia beetle: notes on the work of Xyloterinus politus Say: CARL J. DRAKE.
Phylogeny and distribution of the genus Libellula: CLARENCE H. KENNEDY.
Aids in teaching elementary cytology: Z. P. METCALF.
The cytology of the seaside earwig, Anisolabis: S. I. KORNHAUSER.
Copulation in Planaria maculata: R. A. BUDINGTON.
On the regulative capacity of the neural tube: H. L. WIEMAN.
The musculature of the head and throat of Chimæra ogilvyi: MAE FRIEDLANDER.
New models of the development of the heart in the chick: BRADLEY M. PATTEN.
Some features of the morphology of the kidney of Necturus: S. W. CHASE.
Orientation in the cat: FRANCIS H. HERRICK.
Diet of a captive mole: E. L. MOSELEY.
Additions to the birds of Ohio: LYNDS JONES.
Phagocytosis and clotting in the perivisceral fluid of Arbacia: J. E. KINDRED.
Further observations as to the effect of thyroid substance on plant protoplasm: R. A. BUDINGTON.
The origin and development of the prairie in North America: H. C. SAMPSON.
The significance of native vegetation in crop production: A. E. WALLER.
Energy relations of an acre of corn: E. N. TRANSEAU.
Some energy relations of aquatic life and their significance: L. H. TIFFANY.
Contributions to the genetics and cytology of parthenogenetic Taraxaca: PAUL B. SEARS.
Reversal of the sexual state in Japanese hop: J. H. SCHAFFNER.
The occurrence and abundance of certain algæ in Lake Erie: MALCOLM E. STICKNEY.
The census of flowering plants on certain small islands of Lake Erie: MALCOLM E. STICKNEY.
Causes and consequences of the irregularities in the glacial border in the Ohio Valley: G. FREDERICK WRIGHT.
Explorations in eastern Bolivia: K. F. MATHER.
Some sub-surface rock channels filled with glacial material: J. ERNEST CARMAN.
A fault-zone breccia in the Bass Island series: J. ERNEST CARMAN.
A disconformable contact at the base of the Sylvania sandstone: J. ERNEST CARMAN.
The Ordovician and Silurian seas of American arctic and subarctic regions and the relation of their faunas to contemporaneous seas of European areas: AUGUST FOERSTE.
Some coastal geology of southern Florida: G. F. LAMB.
An interpretation of some Ohio geology: G. F. LAMB.
Richmond Ostracoda of especial interest: W. H. SHIDELER.
Additions to our knowledge of the Arnheim: W. H. SHIDELER.
A Pliocene brackish water fauna near Alexander, La.: E. R. SMITH.
A modification of Hobbs's method of teaching interpretation of geologic maps: E. R. SMITH.
An embryonic volcano in Adams County, Ohio: WALTER H. BUCHER.
Local geology of Cleveland from an economic standpoint: FRANK R. VAN HORN.
The reopening and the end of the Linton (Ohio) Coal-measures fossil-amphibian locality: J. E. HYDE.
The fauna of the Berea Grit; a recurrent Bedford fauna, and its bearing on the age of the Bedford: J. E. HYDE.
Some psychology applied to Americanization: GARRY C. MYERS.
Scientific direction of childhood,—America's greatest social and political responsibility: HERMAN H. YOUNG.
Reliability of survey methods in individual diagnosis: FLORENCE FITZGERALD.
Limiting factors in human behavior: A. P. WEISS.
Waste of mental ability in our school system: HELEN MARSHALL.
(a) Some studies in progress in the Cleveland School of Education: (b) Some data on learning curves: GARRY C. MYERS.
College men in the penitentiary: CARL MURCHISON.
A preliminary report on retroactive inhibition (with particular reference to two conditions): E. B. SKAGGS.
The measurement of psychological effects of fatigue and low oxygen: F. C. DOCKERAY.
Discussion of the legal status of psychology in Ohio State: led by H. AUSTIN AIKINS.

DEMONSTRATIONS

Chromosomal complexes of Anisolabis: S. I. KORNHAUSER.
Geographic distribution maps of the Opalinidæ and their hosts: MAYNARD M. METCALF.
New models of development of the heart in the chick: BRADLEY M. PATTEN.
Chart and data relating to an interesting case of stature inheritance: A. B. PLOWMAN.
Multiple ova in Graafian follicles of cat: EDWARD L. RICE.
Sulphur dioxide injury to vegetation: A. E. WALLER.
Illustrations of euglenoids: L. B. WALTON.

EDWARD L. RICE,
Secretary

DELAWARE, OHIO